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(71) Applicant: **SUZUKI MOTOR CORP**

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(72) Inventor: **YAMAGUCHI JUNJI**

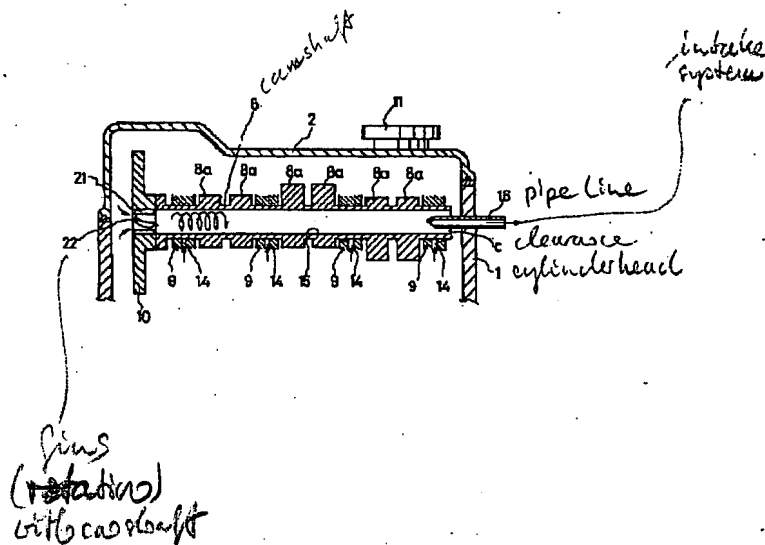
(54) **GAS-LIQUID SEPARATION DEVICE FOR BLOW-BY GAS**

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(57) Abstract:

PURPOSE: To surely separate oil content from blow-by gas, in a gas-liquid separation device for blow-by gas.

CONSTITUTION: A through passage 15 is provided in a camshaft 8 along the axial direction in a cylinder head 1. Fins 22 are provided on the inner wall of the opening 21 of a cam sprocket 10 communicated to the passage 15. A pipe line 16 is inserted through clearance C into the one end opening part of the passage 15, and the pipe line 16 is connected to the intake system of an engine. By intake negative pressure of the engine and rotation of the fins 22, blow-by gas in the cylinder head 1 is introduced in the passage 15, the blow-by gas is rotated by rotation of the fins 22 and the camshaft 8, so as to centrifugally separate oil content from the gas and stick it on the inner wall of the passage 15. The blow-by gas from which oil content is removed is sucked from the pipe line 16 to the intake system. The oil content stuck on the inner wall of the passage 15 is discharged into the cylinder head 1 along the inner wall and through the clearance C.



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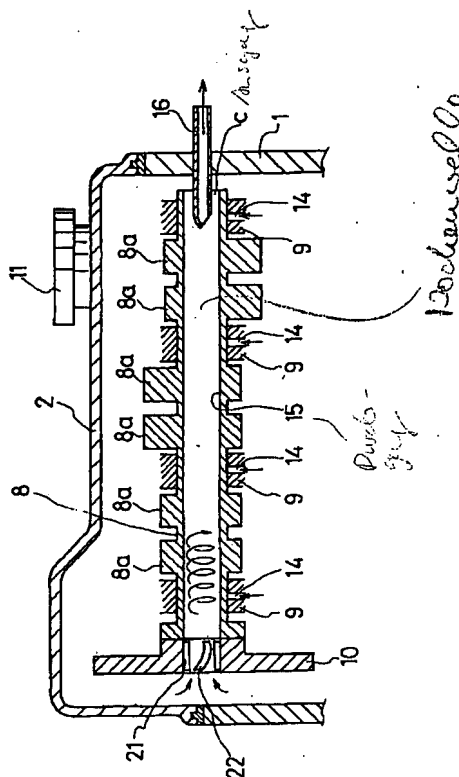
(71) 出願人 000002082  
 スズキ株式会社  
 静岡県浜松市高塚町300番地  
 (72) 発明者 山口 純司  
 静岡県浜松市高塚町300番地 スズキ株式  
 会社内  
 (74) 代理人 弁理士 萆 経夫 (外2名)

(54) 【発明の名称】 ブローバイガスの気液分離装置

(57) 【要約】

【目的】 ブローバイガスの気液分離装置において、ブローバイガス中の油分を確実に分離する。

【構成】 シリンダヘッド1内のカムシャフト8内に、その軸方向に沿って貫通する通路15を設ける。通路15に連通するカムプロケット10の開口21の内壁にフィン22を設ける。通路15の一端開口部に管路16を隙間Cをもって挿入し、管路15をエンジンの吸気系に接続する。エンジンの吸気負圧およびフィン22の回転によって、シリンダヘッド1内のブローバイガスを通路15内に導入し、フィン22およびカムシャフト8の回転によってブローバイガスを旋回させ油分を遠心分離して通路15の内壁に付着させる。油分を除去したブローバイガスを管路16から吸気系に吸入する。通路15の内壁に付着した油分は、内壁をつたって隙間Cからシリンダヘッド1内へ排出される。



## 【特許請求の範囲】

【請求項1】 カムシャフト内にその軸心に沿って貫通するブローパイガス通路を設け、該ブローパイガス通路の一端開口部に隙間をもって管路を挿入し、該管路をエンジンの吸気系に接続したことを特徴とするブローパイガスの気液分離装置。

【請求項2】 ブローパイガス通路内にカムシャフトの回転により管路側に向かって送気するフィンを設けたことを特徴とする請求項1に記載のブローパイガスの気液分離装置。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】 本発明は、ブローパイガス還元装置を備えたエンジンに適用されるブローパイガスの気液分離装置に関するものである。

## 【0002】

【従来の技術】 一般に、レシプロエンジンでは、シリンダとピストンとの隙間からクランク室内へ漏れるブローパイガスの大気中への放出を防ぐために、ブローパイガス還元装置が設けられている。ブローパイガス還元装置は、クランク室に連通するシリンダヘッドの内部を管路によってエンジンの吸気系に接続して、エンジンの吸気負圧を利用してクランク室内のブローパイガスを強制的に吸気系に導入して再燃焼させるようになっている。

【0003】 このようなブローパイガス還元装置を備えたエンジンでは、シリンダヘッド内のブローパイガス中のオイルミストが管路を通して吸気系に吸入されないようにするために、ブローパイガスの気液分離装置が設けられている。

【0004】 次に、従来のブローパイガスの気液分離装置について説明する。例えば図4に示すように、エンジンのシリンダヘッド1の上部に取付けられたシリンダヘッドカバー2内に気液分離室3が設けられている。気液分離室3の内部には、その上下の内壁に交互に配置された複数の隔壁4によって仕切られて屈曲された屈曲路5が形成されている。この屈曲路5の一端側は、導入孔6によってシリンダヘッド1の内部に連通されており、他端側は、管路7によって当該エンジンの吸気系に連通されている。なお、図4中、8はカムシャフト、9は軸受、10はカムスプロケット、11はオイルフィルターキャップである。

【0005】 この構成により、エンジンの吸気負圧によって、シリンダヘッド1内から導入孔6を介して気液分離室3内に導入された油分を含むブローパイガスは、屈曲路5を通過して管路7からエンジンの吸気系に吸入される。このとき、屈曲路5を通過するブローパイガスは、収縮、膨張を繰り返しながら複数の隔壁4に衝突して油分が隔壁4に付着して分離された後、管路7から吸気系に吸入される。

【0006】 また、実開平1-148009号公報に

は、エンジンのカムシャフト内に軸方向に延びる中空部を形成し、カムシャフトの側壁に導入孔を設け、さらに、カムシャフト内の中空部をエンジンの吸気系に連通させるようにしたブローパイガス分離装置が記載されている。そして、この装置は、エンジンの吸気負圧によってシリンダヘッド内からカムシャフトの側壁の導入孔を介して中空部に導入された油分を含むブローパイガスをカムシャフトの回転により遠心分離して油分を除去した後、吸気系に吸入させるようにしている。

## 10 【0007】

【発明が解決しようとする課題】 しかしながら、上記従来のブローパイガスの気液分離装置では、次のような問題がある。

【0008】 図4に示すものでは、屈曲路5内のブローパイガスの流速によって、気体成分と液体成分（油分）とに作用する慣性力の差を利用して気液分離を行っているが、十分な流速を得ることが困難であるため、油分を充分に分離するためには、気液分離室3の容積を大きくする必要がある。このため、シリンダヘッドカバー2が大きくなるという問題がある。

【0009】 また、実開平1-148009号公報に記載されたものでは、カムシャフトの側壁に導入孔が配置されているので、カムシャフトの回転による遠心力が作用してブローパイガスが導入孔へ入りにくくなるため、ブローパイガスの充分な流量が得ることが困難になるという問題がある。

【0010】 本発明は、上記の点に鑑みてなされたものであり、ブローパイガス中の油分を確実に分離するとともに、ブローパイガスの流量を充分に確保することができ、ブローパイガスの気液分離装置を提供することを目的とする。

## 【0011】

【課題を解決するための手段】 上記の課題を解決するために、請求項1に係るブローパイガスの気液分離装置は、カムシャフト内にその軸心に沿って貫通するブローパイガス通路を設け、該ブローパイガス通路の一端開口部に隙間をもって管路を挿入し、該管路をエンジンの吸気系に接続したことを特徴とする。

【0012】 また、請求項2に係るブローパイガスの気液分離装置は、上記の請求項1の構成に加えて、ブローパイガス通路内にカムシャフトの回転により管路側に向かって送気するフィンを設けたことを特徴とする。

## 【0013】

【作用】 このように構成したことにより、請求項1に係るブローパイガスの気液分離装置によれば、エンジン本体内のブローパイガスは、吸気系の負圧によってブローパイガス通路に導入されて管路側に向かって流れ、カムシャフトの回転によって油分が遠心分離された後、管路を通過してエンジンの吸気系へ導入される。遠心分離された油分は、ブローパイガス通路と管路との隙間からエン

ジン本体内部へ排出される。

【0014】さらに、請求項2に係るブローパイガスの気液分離装置によれば、上記に加えて、フィンの送気によって、ブローパイガスのブローパイガス通路内への導入が促進され、また、ブローパイガス通路内の旋回流が強まって遠心分離作用が促進される。

【0015】

【実施例】以下、本発明の一実施例を図面に基づいて詳細に説明する。なお、以下の説明において、図3に示す従来例と同様の部分については同一の番号を付して説明する。

【0016】図1ないし図3に示すように、シリンダヘッド1内に設けられたカムシャフト8は、軸受9によって回転可能に支持されており、その端部にカムスプロケット10が一体に取付けられている。そして、カムシャフト8は、カムスプロケット10に巻装されたタイミングチェーン（図示せず）介して当該エンジンのクランクシャフト（図示せず）によって駆動され、カム8aを回転させることにより、ピストン12のストロークに応じた所定のタイミングで吸排気弁13を開閉させるようになっている。軸受9には、軸受面に潤滑油を供給するための油孔14が設けられている。シリンダヘッド1の上部には、シリンダヘッドカバー2が取付けられ、シリンダヘッドカバー2には、エンジン本体内部に潤滑油を注入するためのオイルフィルターキャップ11が取付けられている。

【0017】カムシャフト8内には、その軸心に沿って貫通する通路15が形成されている。シリンダヘッド1の側壁には、カムシャフト8の一端部に対向する部位に管路16が気密的に挿通されており、この管路16の一端部がカムシャフト8の通路15の開口部の中心に所定の隙間Cをもって挿入されている。通路15内に挿入された管路16の一端部は、下方に向かって開口されている。管路16の他端側は、当該エンジンの吸気系を構成するインレットマニホールド17、吸気管18、エアクリーナ19等（図示のものではエアクリーナ19）にホース20によって接続されており、吸気負圧によって通路15内のブローパイガスを管路16を通して吸気系に吸入するようになっている。なお、ホース20には、吸気系に導入されるブローパイガスの流量を調整するPCV（ポジティブ・クランクケース・ベンチレーション）バルブ（図示せず）が設けられている。

【0018】カムスプロケット10には、カムシャフト8の通路15に連通する開口21が設けられており、通路15および開口21によって、カムスプロケット10が一体に取付けられたカムシャフト8をその軸心に沿って貫通するブローパイガス通路が構成されている。開口21の内周面には、カムシャフト8およびカムスプロケット10の回転により、ブローパイガス通路内を通路15の一端に挿入された管路16側に向かって送気するフィン22が設けられている。

【0019】以上のように構成した本実施例の作用について次に説明する。

【0020】シリンダヘッド1内のブローパイガスは、吸気負圧によってカムスプロケット10の開口21から導入され、カムシャフト8の通路15内を管路16側へ向かって流れ、管路16およびホース20を通過してエアクリーナ19（当該エンジンの吸気系）に導入される。このとき、フィン22がカムシャフト8およびカムスプロケット10の回転により、通路15内のブローパイガスを管路16側へ向かって送気するとともに旋回させる。また、通路15の内壁との摩擦により、カムシャフト8の回転が管路15内のブローパイガスの旋回を促進する。ここで、ブローパイガスは、カムシャフト8の回転の中心に位置するカムスプロケット10の開口21から導入するので、導入時に遠心力が作用することがなく、通路15内に円滑に導入することができ、十分な流量を確保することができる。

【0021】通路15内のブローパイガスが旋回することにより、ブローパイガス中の油分が遠心分離されて通路15の内壁に付着する。そして、通路15を通過する過程で油分が分離されたブローパイガスが通路15の中心部に挿入された管路16を通過して吸気系へ吸入される。なお、管路16に吸入されないブローパイガスは、通路15と管路16との隙間Cを通過してシリンダヘッド1内へ戻る。一方、通路15の内壁に付着した油分は、内壁をつたって通路15と管路16との隙間Cからシリンダヘッド1内へ排出される。通路15内に挿入された管路16の一端は、下方に向かって開口しているので、通路15の内壁に付着した油分がエンジン停止時に滴下して管路16内に入ることがない。

【0022】このようにして、油分を強制的に遠心分離して充分除去した後のブローパイガスを吸気系に導入することができる。また、ブローパイガス通路をカムシャフト8の内部に形成して従来の気液分離室を不要としているので、シリンダヘッドカバーを小型化することができる。

【0023】なお、上記実施例では、ブローパイガスを送気するフィン22は、カムスプロケット10の開口21内に形成されているが、通路15内に形成してもよい。また、他の実施例として、フィン22を省略することもできる。この場合、通路15との摩擦によってブローパイガスを旋回させることができ、吸気負圧によって通路15のブローパイガスを送気することができる。このとき、通路15と管路16と隙間Cを小さくすることにより、吸気負圧による送気を促進することができる。

【0024】

【発明の効果】以上詳述したように、請求項1の発明に係るブローパイガスの気液分離装置によれば、エンジン本体内部のブローパイガスは、吸気系の負圧によってカムシャフト内部のブローパイガス通路に導入されて管路側に向かって流れ、カムシャフトの回転によって油分が遠心分離された後、管路を通過してエンジンの吸気系へ導入さ

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れる。遠心分離された油分は、ブローパイガス通路と管路との隙間からエンジン本体内へ排出される。その結果、油分を強制的に遠心分離して充分除去した後のブローパイガスを吸気系に導入することができる。また、ブローパイガス通路をカムシャフトの内部に形成して従来の気液分離室を不要としているので、シリンダヘッドカバーを小型化することができるという優れた効果を奏する。

【0025】また、請求項2の発明に係るブローパイガスの気液分離装置によれば、上記請求項1の効果に加え、フィンの送気によって、ブローパイガスのブローパイガス通路内への導入が促進され、また、ブローパイガス通路内の旋回流が強まって遠心分離作用が促進される。

#### 【図面の簡単な説明】

【図1】本発明の一実施例を適用したエンジンの概略構

成を示す説明図である。

【図2】本発明の一実施例のブローパイガスの気液分離装置に用いられるカムプロケットの正面図である。

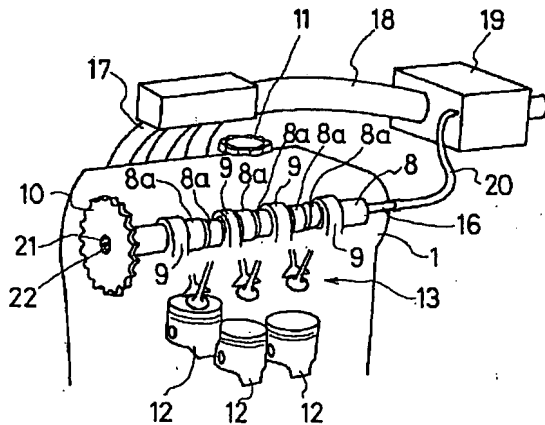
【図3】本発明の一実施例を適用したエンジンのシリンダヘッド部の側面の縦断面図である。

【図4】従来のブローパイガスの気液分離装置を適用したエンジンのシリンダヘッド部の側面の縦断面図である。

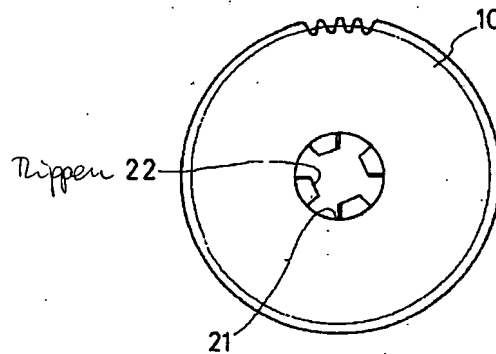
#### 【符号の説明】

- 8 カムシャフト
- 15 通路（ブローパイガス通路）
- 16 管路
- 21 開口（ブローパイガス通路）
- 19 エアクリーナ（エンジンの吸気系）
- 22 フィン
- C 隙間

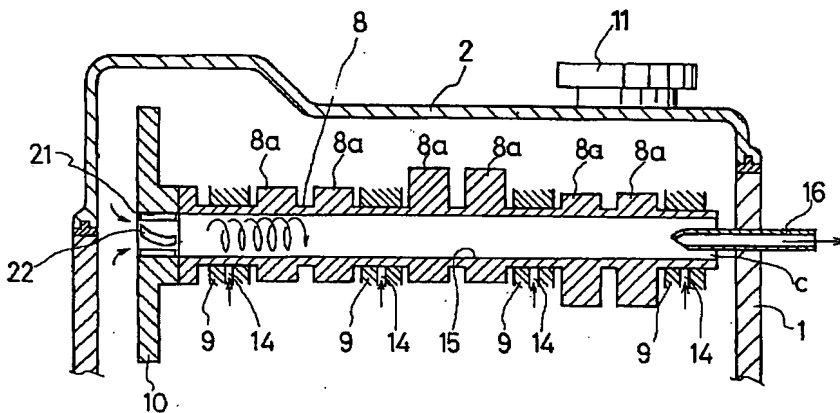
【図1】



【図2】



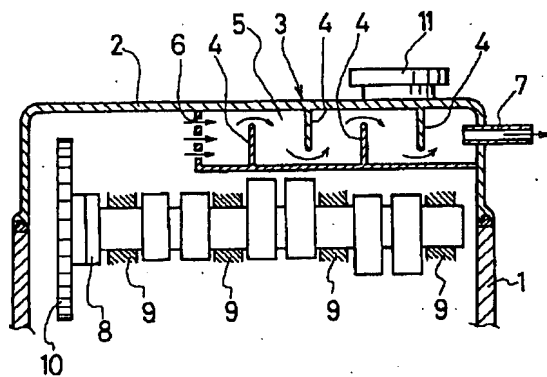
【図3】



(5)

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【図4】



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(21)Application number : 07-107953 (71)Applicant : SUZUKI MOTOR CORP

(22)Date of filing : 07.04.1995 (72)Inventor : YAMAGUCHI JUNJI

## (54) GAS-LIQUID SEPARATION DEVICE FOR BLOW-BY GAS

### (57)Abstract:

PURPOSE: To surely separate oil content from blow-by gas, in a gas-liquid separation device for blow-by gas.

CONSTITUTION: A through passage 15 is provided in a camshaft 8 along the axial direction in a cylinder head 1.

Fins 22 are provided on the inner wall of the opening 21 of a cam sprocket 10 communicated to the passage 15.

A pipe line 16 is inserted through clearance C into the one end opening part of the passage 15, and the pipe line 16 is connected to the intake system of an engine.

By intake negative pressure of the engine and rotation of the fins 22, blow-by gas in the cylinder head 1 is

introduced in the passage 15, the blow-by gas is rotated

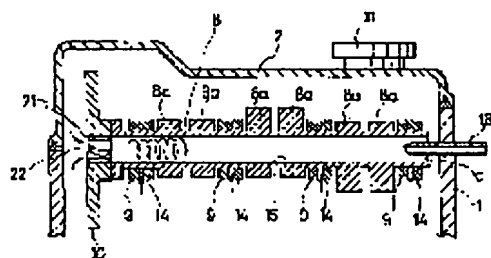
by rotation of the fins 22 and the camshaft 8, so as to

centrifugally separate oil content from the gas and stick it

on the inner wall of the passage 15. The blow-by gas from which oil content is removed is

sucked from the pipe line 16 to the intake system. The oil content stuck on the inner wall of

the passage 15 is discharged into the cylinder head 1 along the inner wall and through the clearance C.



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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]**

**[0001]**

**[Industrial Application]** This invention relates to the vapor-liquid-separation equipment of the blow-by gas applied to the engine equipped with positive crankcase ventilation.

**[0002]**

**[Description of the Prior Art]** Generally, in the reciprocating engine, in order to prevent emission into the atmospheric air of the blow-by gas which leaks from the clearance between a cylinder and a piston into a crank case, positive crankcase ventilation is formed. Positive crankcase ventilation connects to an engine inhalation-of-air system the interior of the cylinder head which is open for free passage to a crank case by the duct, introduces the blow-by gas in a crank case into an inhalation-of-air system compulsorily, and makes it afterburn using engine inhalation-of-air negative pressure.

**[0003]** With the engine equipped with such positive crankcase ventilation, in order for the oil mist in the blow-by gas in the cylinder head not to be inhaled by the inhalation-of-air system through a duct, the vapor-liquid-separation equipment of blow-by gas is formed.

**[0004]** Next, the vapor-liquid-separation equipment of conventional blow-by gas is explained. For example, as shown in drawing 4, the vapor-liquid-separation room 3 is formed in the cylinder head cover 2 attached in the upper part of the engine cylinder head 1. The crookedness way 5 divided and crooked by two or more septa 4 arranged by turns in the wall of the upper and lower sides is formed in the interior of the vapor-liquid-separation room 3. The end side of this crookedness way 5 is opened for free passage inside the cylinder head 1 with the introductory hole 6, and the other end side is opened for free passage by the duct 7 at the inhalation-of-air system of the engine concerned. In addition, for eight, as for bearing and 10, a cam shaft and 9 are [ a cam sprocket and 11 ] oil filler caps among drawing 4.

**[0005]** By this configuration, the blow-by gas containing the oil introduced by engine inhalation-of-air negative pressure in the vapor-liquid-separation room 3 through the introductory hole 6 from the inside of the cylinder head 1 is inhaled by the engine inhalation-of-air system from a duct 7 through the crookedness way 5. Repeating contraction and expansion, the blow-by gas which passes through the crookedness way 5 at this time collides with two or more septa 4, and after oil is adhered and divided into a septum 4, it is inhaled by the inhalation-of-air system from a duct 7.

**[0006]** Moreover, the centrum prolonged in shaft orientations is formed in an engine cam shaft, an introductory hole is prepared in the side attachment wall of a cam shaft, and the blow-by gas decollator it was made to make an engine inhalation-of-air system open the centrum in a cam shaft for free passage is further indicated by JP,1-148009,U. And after this equipment carries out centrifugal separation of the blow-by gas containing the oil introduced into the centrum by engine inhalation-of-air negative pressure through the introductory hole of the side attachment wall of a cam shaft from the inside of the cylinder head by rotation of a cam shaft and removes oil, he is trying to make an inhalation-of-air system inhale it.

**[0007]**

**[Problem(s) to be Solved by the Invention]** However, there are the following problems with the vapor-



liquid-separation equipment of the above-mentioned conventional blow-by gas.

[0008] Although the rate of flow of the blow-by gas in the crookedness way 5 is performing vapor liquid separation in what is shown in drawing 4 using the difference of the inertial force which acts on a gas component and a liquid component (oil), since it is difficult to acquire sufficient rate of flow, in order to fully separate oil, it is necessary to enlarge the volume of the vapor-liquid-separation room 3. For this reason, there is a problem that a cylinder head cover 2 becomes large.

[0009] Moreover, in some which were indicated by JP,1-148009,U, since the introductory hole is arranged at the side attachment wall of a cam shaft, the centrifugal force by rotation of a cam shaft acts and blow-by gas stops being able to go into an introductory hole easily, there is a problem that it becomes difficult for sufficient flow rate of blow-by gas to obtain.

[0010] This invention aims at offering the vapor-liquid-separation equipment of the blow-by gas which can fully secure the flow rate of blow-by gas while it is made in view of the above-mentioned point and separates the oil in blow-by gas certainly.

[0011]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the vapor-liquid-separation equipment of the blow-by gas concerning claim 1 prepares the blow-by gas path penetrated along with the axial center in a cam shaft, inserts a duct in end opening of this blow-by gas path with a clearance, and is characterized by connecting this duct to an engine inhalation-of-air system.

[0012] Moreover, the vapor-liquid-separation equipment of the blow-by gas concerning claim 2 is characterized by preparing the fin which carries out a supplied air toward a duct side by rotation of a cam shaft in a blow-by gas path in addition to the configuration of above-mentioned claim 1.

[0013]

[Function] Thus, according to the vapor-liquid-separation equipment of the blow-by gas which starts claim 1 by having constituted, the blow-by gas of the engine book inside of the body is introduced through a duct to an engine inhalation-of-air system, after being introduced into a blow-by gas path by the negative pressure of an inhalation-of-air system, flowing toward a duct side with it and centrifugal separation of the oil being carried out by rotation of a cam shaft. The oil by which centrifugal separation was carried out is discharged from the clearance between a blow-by gas path and a duct to the engine book inside of the body.

[0014] Furthermore, according to the vapor-liquid-separation equipment of the blow-by gas concerning claim 2, in addition to the above, installation into the blow-by gas path of blow-by gas is promoted, and the revolution style in a blow-by gas path becomes strong, and a centrifugal separation operation is promoted by the supplied air of a fin.

[0015]

[Example] Hereafter, one example of this invention is explained to a detail based on a drawing. In addition, in the following explanation, the same number is attached and explained about the same part as the conventional example shown in drawing 3.

[0016] As shown in drawing 1 thru/or drawing 3, the cam shaft 8 prepared in the cylinder head 1 is supported by bearing 9 pivotable, and the cam sprocket 10 is attached in the edge at one. And it minds a timing chain (not shown), and drives with the crankshaft (not shown) of the engine concerned, and a cam shaft 8 makes an induction-exhaust valve 13 open and close to the predetermined timing according to the stroke of a piston 12 by [ the cam sprocket 10 was looped around ] rotating cam 8a. The oil gallery 14 for supplying a lubricating oil to the bearing surface is formed in bearing 9. A cylinder head cover 2 is attached in the upper part of the cylinder head 1, and the oil filler cap 11 for injecting a lubricating oil into the engine book inside of the body is attached in it at the cylinder head cover 2.

[0017] In the cam shaft 8, the path 15 penetrated along with the axial center is formed. The duct 16 is inserted in the part which counters the end section of a cam shaft 8 in airtight, and the end section of this duct 16 is inserted in the side attachment wall of the cylinder head 1 with the predetermined clearance C at the core of opening of the path 15 of a cam shaft 8. The end section of the duct 16 inserted into the path 15 goes caudad, and opening is carried out. The hose 20 connects with the inlet manifold 17 which constitutes the inhalation-of-air system of the engine concerned, the inlet pipe 18, and the air cleaner 19

grade (the thing of illustration air cleaner 19), and the other end side of a duct 16 inhales the blow-by gas in a path 15 in an inhalation-of-air system through a duct 16 with inhalation-of-air negative pressure. In addition, the PCV (positive crank-case ventilation) bulb (not shown) which adjusts the flow rate of the blow-by gas introduced into an inhalation-of-air system to a hose 20 is prepared.

[0018] The opening 21 which is open for free passage to the path 15 of a cam shaft 8 is formed in the cam sprocket 10, and the blow-by gas path where the cam sprocket 10 penetrates the cam shaft 8 attached in one along with the axial center by the path 15 and opening 21 is constituted. The fin 22 which carries out the supplied air of the inside of a blow-by gas path to the inner skin of opening 21 by rotation of a cam shaft 8 and the cam sprocket 10 toward the duct 16 side in which it was inserted by the end of a path 15 is formed.

[0019] An operation of this example constituted as mentioned above is explained below.

[0020] The blow-by gas in the cylinder head 1 is introduced by inhalation-of-air negative pressure from the opening 21 of the cam sprocket 10, flows the inside of the path 15 of a cam shaft 8 toward a duct 16 side with it, and is introduced into an air cleaner 19 (inhalation-of-air system of the engine concerned) through a duct 16 and a hose 20. A fin 22 makes it circle by rotation of a cam shaft 8 and the cam sprocket 10 at this time, while carrying out the supplied air of the blow-by gas in a path 15 toward a duct 16 side. Moreover, rotation of a cam shaft 8 promotes revolution of the blow-by gas in a duct 15 by friction with the wall of a path 15. Here, since blow-by gas is introduced from the opening 21 of the cam sprocket 10 located at the core of rotation of a cam shaft 8, a centrifugal force cannot act at the time of installation, and it can be smoothly introduced in a path 15, and can secure sufficient flow rate.

[0021] When the blow-by gas in a path 15 circles, centrifugal separation of the oil in blow-by gas is carried out, and it adheres to the wall of a path 15. And the blow-by gas with which oil was separated is inhaled through the duct 16 inserted in the core of a path 15 to an inhalation-of-air system in the process in which it passes through a path 15. In addition, the blow-by gas which is not inhaled in a duct 16 returns into the cylinder head 1 through the clearance C between a path 15 and a duct 16. On the other hand, the oil adhering to the wall of a path 15 is discharged into the cylinder head 1 from the clearance C between a path 15 and a duct 16 as \*\*\*\* in a wall. The end of the duct 16 inserted into the path 15 goes caudad, and since opening is carried out, the oil adhering to the wall of a path 15 trickles it at the time of an engine shutdown, and it does not enter in a duct 16.

[0022] Thus, blow-by gas after carrying out centrifugal separation of the oil compulsorily and removing it enough can be introduced into an inhalation-of-air system. Moreover, since a blow-by gas path is formed in the interior of a cam shaft 8 and the conventional vapor-liquid-separation room is made unnecessary, a cylinder head cover can be miniaturized.

[0023] In addition, in the above-mentioned example, although the fin 22 which carries out the supplied air of the blow-by gas is formed in the opening 21 of the cam sprocket 10, it may be formed in a path 15. Moreover, a fin 22 is also omissible as other examples. in this case, it can be made to circle in blow-by gas by friction with a path 15, and carrying out the supplied air of the blow-by gas of a path 15 with inhalation-of-air negative pressure cuts. At this time, the supplied air by inhalation-of-air negative pressure can be promoted by making small a path 15, a duct 16, and Clearance C.

[0024]

[Effect of the Invention] As explained in full detail above, according to the vapor-liquid-separation equipment of the blow-by gas concerning invention of claim 1, the blow-by gas of the engine book inside of the body is introduced through a duct to an engine inhalation-of-air system, after being introduced into the blow-by gas path in a cam shaft by the negative pressure of an inhalation-of-air system, flowing toward a duct side with it and centrifugal separation of the oil being carried out by rotation of a cam shaft. The oil by which centrifugal separation was carried out is discharged from the clearance between a blow-by gas path and a duct to the engine book inside of the body. Consequently, blow-by gas after carrying out centrifugal separation of the oil compulsorily and removing it enough can be introduced into an inhalation-of-air system. Moreover, since a blow-by gas path is formed in the interior of a cam shaft and the conventional vapor-liquid-separation room is made unnecessary, the outstanding effectiveness that a cylinder head cover can be miniaturized is done so.

[0025] Moreover, according to the vapor-liquid-separation equipment of the blow-by gas concerning invention of claim 2, in addition to the effectiveness of above-mentioned claim 1, installation into the blow-by gas path of blow-by gas is promoted, and the revolution style in a blow-by gas path becomes strong, and a centrifugal separation operation is promoted by the supplied air of a fin.

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CLAIMS

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[Claim(s)]

[Claim 1] Vapor-liquid-separation equipment of the blow-by gas characterized by having prepared the blow-by gas path penetrated along with the axial center in the cam shaft, having inserted the duct in end opening of this blow-by gas path with the clearance, and connecting this duct to an engine inhalation-of-air system.

[Claim 2] Vapor-liquid-separation equipment of the blow-by gas according to claim 1 characterized by preparing the fin which carries out a supplied air toward a duct side by rotation of a cam shaft in a blow-by gas path.

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**TECHNICAL FIELD**

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[Industrial Application] This invention relates to the vapor-liquid-separation equipment of the blow-by gas applied to the engine equipped with positive crankcase ventilation.

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PRIOR ART

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[Description of the Prior Art] Generally, in the reciprocating engine, in order to prevent emission into the atmospheric air of the blow-by gas which leaks from the clearance between a cylinder and a piston into a crank case, positive crankcase ventilation is formed. Positive crankcase ventilation connects to an engine inhalation-of-air system the interior of the cylinder head which is open for free passage to a crank case by the duct, introduces the blow-by gas in a crank case into an inhalation-of-air system compulsorily, and makes it afterburn using engine inhalation-of-air negative pressure.

[0003] With the engine equipped with such positive crankcase ventilation, in order for the oil mist in the blow-by gas in the cylinder head not to be inhaled by the inhalation-of-air system through a duct, the vapor-liquid-separation equipment of blow-by gas is formed.

[0004] Next, the vapor-liquid-separation equipment of conventional blow-by gas is explained. For example, as shown in drawing 4, the vapor-liquid-separation room 3 is formed in the cylinder head cover 2 attached in the upper part of the engine cylinder head 1. The crookedness way 5 divided and crooked by two or more septa 4 arranged by turns in the wall of the upper and lower sides is formed in the interior of the vapor-liquid-separation room 3. The end side of this crookedness way 5 is opened for free passage inside the cylinder head 1 with the introductory hole 6, and the other end side is opened for free passage by the duct 7 at the inhalation-of-air system of the engine concerned. In addition, for eight, as for bearing and 10, a cam shaft and 9 are [ a cam sprocket and 11 ] oil filler caps among drawing 4.

[0005] By this configuration, the blow-by gas containing the oil introduced by engine inhalation-of-air negative pressure in the vapor-liquid-separation room 3 through the introductory hole 6 from the inside of the cylinder head 1 is inhaled by the engine inhalation-of-air system from a duct 7 through the crookedness way 5. Repeating contraction and expansion, the blow-by gas which passes through the crookedness way 5 at this time collides with two or more septa 4, and after oil is adhered and divided into a septum 4, it is inhaled by the inhalation-of-air system from a duct 7.

[0006] Moreover, the centrum prolonged in shaft orientations is formed in an engine cam shaft, an introductory hole is prepared in the side attachment wall of a cam shaft, and the blow-by gas decollator it was made to make an engine inhalation-of-air system open the centrum in a cam shaft for free passage is further indicated by JP,1-148009,U.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] As explained in full detail above, according to the vapor-liquid-separation equipment of the blow-by gas concerning invention of claim 1, the blow-by gas of the engine book inside of the body is introduced through a duct to an engine inhalation-of-air system, after being introduced into the blow-by gas path in a cam shaft by the negative pressure of an inhalation-of-air system, flowing toward a duct side with it and centrifugal separation of the oil being carried out by rotation of a cam shaft. The oil by which centrifugal separation was carried out is discharged from the clearance between a blow-by gas path and a duct to the engine book inside of the body. Consequently, blow-by gas after carrying out centrifugal separation of the oil compulsorily and removing it enough can be introduced into an inhalation-of-air system. Moreover, since a blow-by gas path is formed in the interior of a cam shaft and the conventional vapor-liquid-separation room is made unnecessary, the outstanding effectiveness that a cylinder head cover can be miniaturized is done so.

[0025] Moreover, according to the vapor-liquid-separation equipment of the blow-by gas concerning invention of claim 2, in addition to the effectiveness of above-mentioned claim 1, installation into the blow-by gas path of blow-by gas is promoted, and the revolution style in a blow-by gas path becomes strong, and a centrifugal separation operation is promoted by the supplied air of a fin.

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**TECHNICAL PROBLEM**

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[Problem(s) to be Solved by the Invention] However, there are the following problems with the vapor-liquid-separation equipment of the above-mentioned conventional blow-by gas.

[0008] Although the rate of flow of the blow-by gas in the crookedness way 5 is performing vapor liquid separation in what is shown in drawing 4 using the difference of the inertial force which acts on a gas component and a liquid component (oil), since it is difficult to acquire sufficient rate of flow, in order to fully separate oil, it is necessary to enlarge the volume of the vapor-liquid-separation room 3. For this reason, there is a problem that a cylinder head cover 2 becomes large.

[0009] Moreover, in some which were indicated by JP,1-148009,U, since the introductory hole is arranged at the side attachment wall of a cam shaft, the centrifugal force by rotation of a cam shaft acts and blow-by gas stops being able to go into an introductory hole easily, there is a problem that it becomes difficult for sufficient flow rate of blow-by gas to obtain.

[0010] This invention aims at offering the vapor-liquid-separation equipment of the blow-by gas which can fully secure the flow rate of blow-by gas while it is made in view of the above-mentioned point and separates the oil in blow-by gas certainly.

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MEANS

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[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the vapor-liquid-separation equipment of the blow-by gas concerning claim 1 prepares the blow-by gas path penetrated along with the axial center in a cam shaft, inserts a duct in end opening of this blow-by gas path with a clearance, and is characterized by connecting this duct to an engine inhalation-of-air system. [0012] Moreover, the vapor-liquid-separation equipment of the blow-by gas concerning claim 2 is characterized by preparing the fin which carries out a supplied air toward a duct side by rotation of a cam shaft in a blow-by gas path in addition to the configuration of above-mentioned claim 1.

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**OPERATION**

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[Function] Thus, according to the vapor-liquid-separation equipment of the blow-by gas which starts claim 1 by having constituted, the blow-by gas of the engine book inside of the body is introduced through a duct to an engine inhalation-of-air system, after being introduced into a blow-by gas path by the negative pressure of an inhalation-of-air system, flowing toward a duct side with it and centrifugal separation of the oil being carried out by rotation of a cam shaft. The oil by which centrifugal separation was carried out is discharged from the clearance between a blow-by gas path and a duct to the engine book inside of the body.

[0014] Furthermore, according to the vapor-liquid-separation equipment of the blow-by gas concerning claim 2, in addition to the above, installation into the blow-by gas path of blow-by gas is promoted, and the revolution style in a blow-by gas path becomes strong, and a centrifugal separation operation is promoted by the supplied air of a fin.

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EXAMPLE

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[Example] Hereafter, one example of this invention is explained to a detail based on a drawing. In addition, in the following explanation, the same number is attached and explained about the same part as the conventional example shown in drawing 3 .

[0016] As shown in drawing 1 thru/or drawing 3 , the cam shaft 8 prepared in the cylinder head 1 is supported by bearing 9 pivotable, and the cam sprocket 10 is attached in the edge at one. And it minds a timing chain (not shown), and drives with the crankshaft (not shown) of the engine concerned, and a cam shaft 8 makes an induction-exhaust valve 13 open and close to the predetermined timing according to the stroke of a piston 12 by [ the cam sprocket 10 was looped around ] rotating cam 8a. The oil gallery 14 for supplying a lubricating oil to the bearing surface is formed in bearing 9. A cylinder head cover 2 is attached in the upper part of the cylinder head 1, and the oil filler cap 11 for injecting a lubricating oil into the engine book inside of the body is attached in it at the cylinder head cover 2.

[0017] In the cam shaft 8, the path 15 penetrated along with the axial center is formed. The duct 16 is inserted in the part which counters the end section of a cam shaft 8 in airtight, and the end section of this duct 16 is inserted in the side attachment wall of the cylinder head 1 with the predetermined clearance C at the core of opening of the path 15 of a cam shaft 8. The end section of the duct 16 inserted into the path 15 goes caudad, and opening is carried out. The hose 20 connects with the inlet manifold 17 which constitutes the inhalation-of-air system of the engine concerned, the inlet pipe 18, and the air cleaner 19 grade (the thing of illustration air cleaner 19), and the other end side of a duct 16 inhales the blow-by gas in a path 15 in an inhalation-of-air system through a duct 16 with inhalation-of-air negative pressure. In addition, the PCV (positive crank-case ventilation) bulb (not shown) which adjusts the flow rate of the blow-by gas introduced into an inhalation-of-air system to a hose 20 is prepared.

[0018] The opening 21 which is open for free passage to the path 15 of a cam shaft 8 is formed in the cam sprocket 10, and the blow-by gas path where the cam sprocket 10 penetrates the cam shaft 8 attached in one along with the axial center by the path 15 and opening 21 is constituted. The fin 22 which carries out the supplied air of the inside of a blow-by gas path to the inner skin of opening 21 by rotation of a cam shaft 8 and the cam sprocket 10 toward the duct 16 side in which it was inserted by the end of a path 15 is formed.

[0019] An operation of this example constituted as mentioned above is explained below.

[0020] The blow-by gas in the cylinder head 1 is introduced by inhalation-of-air negative pressure from the opening 21 of the cam sprocket 10, flows the inside of the path 15 of a cam shaft 8 toward a duct 16 side with it, and is introduced into an air cleaner 19 (inhalation-of-air system of the engine concerned) through a duct 16 and a hose 20. A fin 22 makes it circle by rotation of a cam shaft 8 and the cam sprocket 10 at this time, while carrying out the supplied air of the blow-by gas in a path 15 toward a duct 16 side. Moreover, rotation of a cam shaft 8 promotes revolution of the blow-by gas in a duct 15 by friction with the wall of a path 15. Here, since blow-by gas is introduced from the opening 21 of the cam sprocket 10 located at the core of rotation of a cam shaft 8, a centrifugal force cannot act at the time of installation, and it can be smoothly introduced in a path 15, and can secure sufficient flow rate.

[0021] When the blow-by gas in a path 15 circles, centrifugal separation of the oil in blow-by gas is

carried out, and it adheres to the wall of a path 15. And the blow-by gas with which oil was separated is inhaled through the duct 16 inserted in the core of a path 15 to an inhalation-of-air system in the process in which it passes through a path 15. In addition, the blow-by gas which is not inhaled in a duct 16 returns into the cylinder head 1 through the clearance C between a path 15 and a duct 16. On the other hand, the oil adhering to the wall of a path 15 is discharged into the cylinder head 1 from the clearance C between a path 15 and a duct 16 as \*\*\*\* in a wall. The end of the duct 16 inserted into the path 15 goes caudad, and since opening is carried out, the oil adhering to the wall of a path 15 trickles it at the time of an engine shutdown, and it does not enter in a duct 16.

[0022] Thus, blow-by gas after carrying out centrifugal separation of the oil compulsorily and removing it enough can be introduced into an inhalation-of-air system. Moreover, since a blow-by gas path is formed in the interior of a cam shaft 8 and the conventional vapor-liquid-separation room is made unnecessary, a cylinder head cover can be miniaturized.

[0023] In addition, in the above-mentioned example, although the fin 22 which carries out the supplied air of the blow-by gas is formed in the opening 21 of the cam sprocket 10, it may be formed in a path 15. Moreover, a fin 22 is also omissible as other examples. in this case, it can be made to circle in blow-by gas by friction with a path 15, and carrying out the supplied air of the blow-by gas of a path 15 with inhalation-of-air negative pressure cuts. At this time, the supplied air by inhalation-of-air negative pressure can be promoted by making small a path 15, a duct 16, and Clearance C.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] It is the explanatory view showing the outline configuration of the engine which applied one example of this invention.

[Drawing 2] It is the front view of a cam sprocket used for the vapor-liquid-separation equipment of the blow-by gas of one example of this invention.

[Drawing 3] It is drawing of longitudinal section of the side face of the cylinder head section of the engine which applied one example of this invention.

[Drawing 4] It is drawing of longitudinal section of the side face of the cylinder head section of the engine which applied the vapor-liquid-separation equipment of conventional blow-by gas.

[Description of Notations]

8 Cam Shaft

15 Path (Blow-by Gas Path)

16 Duct

21 Opening (Blow-by Gas Path)

19 Air Cleaner (Engine Inhalation-of-Air System)

22 Fin

C Clearance

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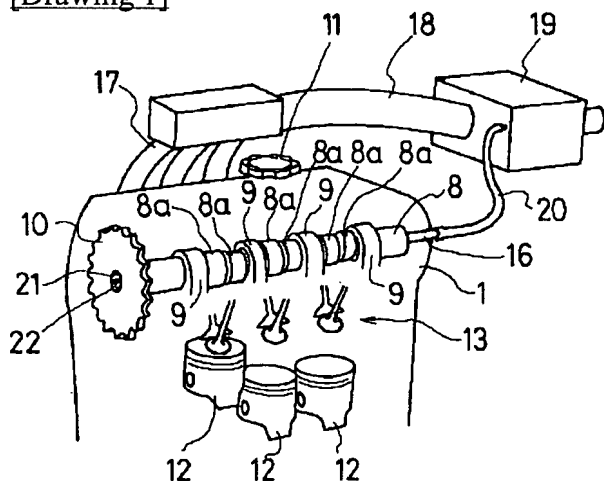
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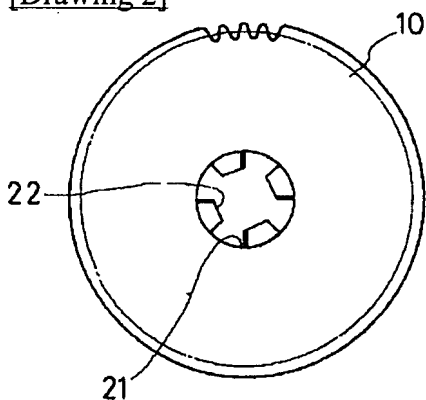
DRAWINGS

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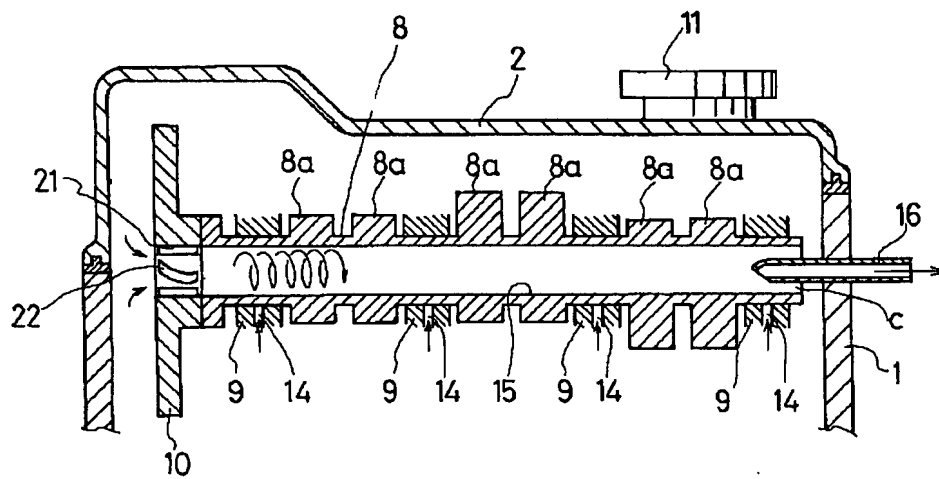
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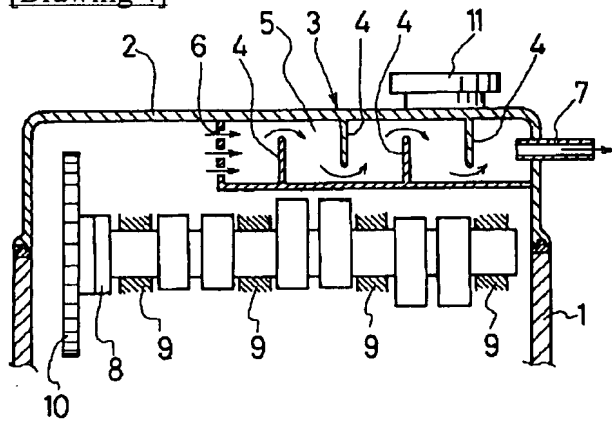
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]